

INDOOR AIR QUALITY ASSESSMENT

**Leicester Middle School
Gymnasium and Locker Rooms
70 Winslow Avenue
Leicester, Massachusetts**



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of Mr. Carl Wickland, Facilities Manager of the Leicester School Department, an indoor air quality assessment was conducted in the gymnasium, athletic department offices and locker rooms at the Leicester Middle School (the school) in Leicester, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA).

The school was previously visited by Cory Holmes, Environmental Analyst of BEHA's Emergency Response/ Indoor Air Quality Program, on February 10, 1999 to conduct an indoor air assessment and a report was issued (MDPH, 1999). The report showed that there were problems identified and gave recommendations on how to correct those problems. Mr. Holmes returned to the school on November 4, 1999 to conduct a follow-up assessment and a report was issued offering further recommendations to improve indoor air quality (MDPH, 2000). Mr. Holmes returned to the school on May 25, 2001 to assess the gymnasium areas listed above.

The purpose of the most recent visit was to investigate possible causes of increased symptoms experienced by a student and was requested by the student's parent(s) and physician. The student was on medication due to allergies to molds and pollens and reportedly experienced increased symptoms on gym class days.

Methods

In addition to visual inspection for microbial growth and/or water damaged building materials, BEHA staff conducted a series of tests for general indoor air quality.

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The school houses grades 6 through 8 with a student population of approximately 450 and a staff of approximately 50. During the assessment, the gymnasium was not being used due to renovations. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were below 800 parts per million (ppm) in all areas surveyed, indicating adequate airflow in these areas of the school. It is important to note, however, that the areas were unoccupied during the assessment, which can greatly contribute to reduced carbon dioxide levels.

During the assessment, all mechanical ventilation system components were deactivated due to renovations. Fresh air in the gymnasium and locker rooms is supplied by an air-handling unit (AHU) located in a mechanical room near the gymnasium (see Picture 1). Fresh air is introduced into the unit through an air intake on the exterior of the building (see Picture 2) and distributed via wall and/or ceiling-mounted air diffusers (see Pictures 3 & 4). Exhaust ventilation is provided by wall-mounted return vents that draw air back to the AHU via ductwork. School officials stated that an HVAC consultant working for the Leicester School Department found the louvers to the return vents closed,

which would interfere with proper airflow into the vents. BEHA staff confirmed that the return louvers were closed.

Fresh air in the weight room is supplied by two ceiling-mounted unit ventilators (univents) (see Picture 5). Univents draw air from outdoors through a fresh air intake located on the exterior walls of a building (see Picture 6) and return air to the unit through an air intake located at the base of each unit. The mixture of fresh and return air is drawn through a filter and a heating coil, and is then expelled from the univent by motorized fans through fresh air diffusers (see [Figure 1](#)). As with the AHU, this system was not operating during the assessment. Exhaust ventilation for the weight room and locker rooms is provided by wall/ceiling-mounted grilles connected to rooftop motors via ductwork (see Pictures 7 & 8).

In order to have proper ventilation with a univent and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature measurements ranged from 62 ° F to 64 ° F, which were below BEHA's recommended comfort range of 70 ° F to 78 ° F. This condition is likely due to the deactivation of the HVAC system due to renovation. It is difficult to control temperature and maintain comfort without operating the HVAC system as designed. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in the building was within the BEHA recommended comfort range in all areas sampled. Relative humidity measurements ranged from 49 to 53 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent.

Of note is that indoor relative humidity measurements exceeded outdoor levels by a range of 10-14 percent. The increase in relative humidity can indicate that the exhaust system is not operating sufficiently to remove water vapor produced by use of showers as well as building occupants. Relative humidity would be expected to rise with occupancy (water vapor from respiration). According to the American Society for Heating, Refrigerating and Air-conditioning Engineers (ASHRAE), relative humidity levels greater than 70 percent can provide sufficient moisture to cause mold growth indoors (ASHRAE, 1989). Where an indoor environment has a relative humidity above 70 percent, the identification and elimination of moisture sources indoors is essential to prevent mold.

Moisture removal is important since the sensation of heat conditions increases as relative humidity increases (the relationship between temperature and relative humidity is called the heat index). As indoor temperature rises, the addition of more relative humidity will make occupants feel hotter than the actual temperature. As an example, a temperature of 75° F with relative humidity of 50 percent would produce a heat index so that an individual would feel the temperature as equivalent to 81° F (USFA/FEMA, 2000). If moisture is removed, the comfort of the individual is increased. Removal of moisture from the air, however, can have some negative effects. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

As mentioned previously, the assessment occurred after three days of rain. No active water leaks were reported or observed in the gymnasium or girl's locker rooms and no active mold growth was observed. Evidence of historic water damage was noted on ceiling plaster. Water intrusion was evident by the presence of efflorescence (e.g., mineral deposits) and peeling paint (see Pictures 9 & 10). Efflorescence is a characteristic sign of water damage to brick and mortar, but it is not mold growth. As moisture penetrates and works its way through mortar around brick, water-soluble compounds in bricks and mortar dissolve, creating a solution. As the solution moves to the surface of the brick or mortar, water evaporates, leaving behind white, powdery mineral deposits. Wall/ceiling plaster is not a good mold growth media, however water trapped behind wallpaper or paint coats can become mold growth media. These materials should be replaced/repared after a water leak is discovered.

Active mold growth was observed in the boy's locker room on the ceiling and on shower tiles (see Pictures 11 & 12). The mold appeared to be common mold growth associated with moisture accumulation/high relative humidity due to shower usage rather than due to chronic water damage from plumbing and/or outdoor leaks.

Other Concerns

Several conditions that can potentially affect indoor air quality were also identified. BEHA staff examined the gymnasium AHU and found the filter coated with dirt/dust and accumulated material (see Picture 13). A debris-saturated filter can obstruct airflow, damage equipment and may serve as a reservoir of particulates that can be re-aerosolized and distributed into occupied areas via the ventilation system.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Once renovations are complete, operate mechanical ventilation in the gymnasium and locker rooms during hours of school occupation.
2. Inspect mechanical ventilation components regularly for proper function. Repair and replace motors and belts as necessary.
3. Remove all blockages from supply and exhaust vents. Inspect periodically to ensure these areas remain free from obstructions.
4. Consider having the ventilation system balanced by an HVAC engineering firm.
5. Disinfect areas with active mold growth with an appropriate antimicrobial.
6. Repair water damaged plaster/peeling paint.
7. Change/clean filters in univents and AHUs as per the manufacturer's instructions (or more frequently if needed) to prevent the re-aerosolization of dirt, dust and particulate matter.

In addition to the specific steps previously noted the MDPH suggests that the following recommendations should be implemented in order to reduce the migration of renovation generated pollutants into occupied areas for any renovation project within a public building:

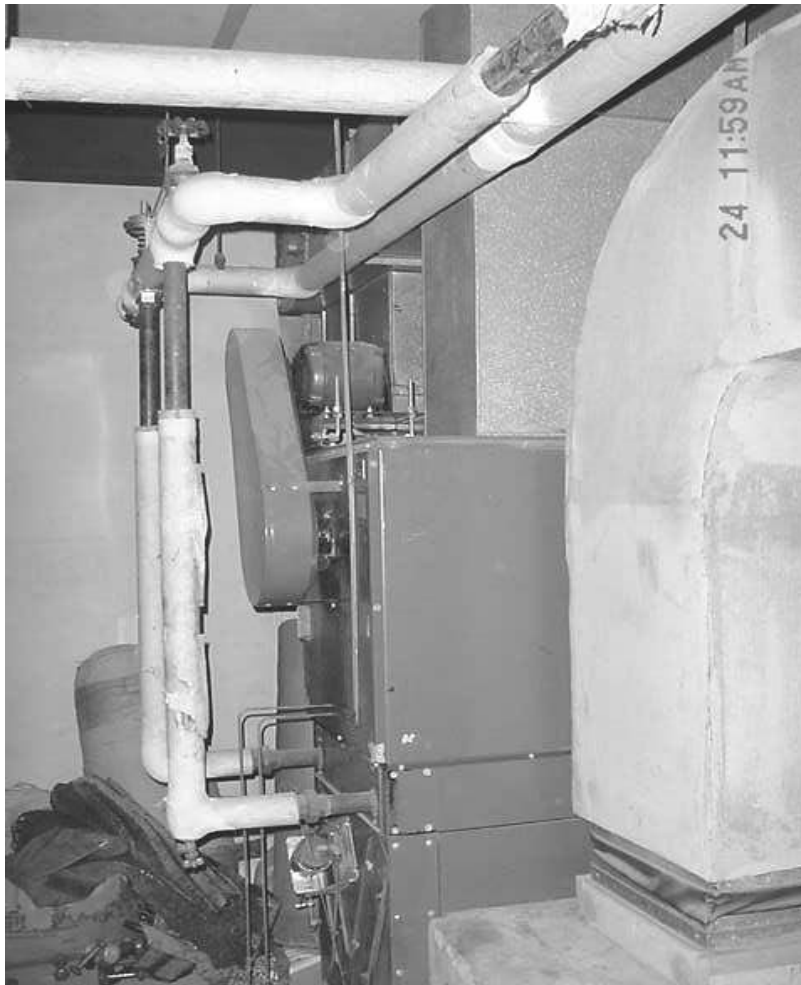
1. Establish communications between all parties involved with building renovations to prevent potential IAQ problems. Develop a forum for occupants to express concerns about renovations as well as a program to resolve IAQ issues.
2. Develop a notification system for building occupants immediately adjacent to construction activities to report construction/renovation-related odors and/or dust(s) problems to the building administrator. Have these concerns relayed to the contractor in a manner to allow for a timely remediation of the problem.
3. When possible, schedule projects which produce large amounts of dusts, odors and emissions during unoccupied periods or periods of low occupancy.
4. Disseminate scheduling itinerary to all affected parties. This can be done in the form of meetings, newsletters or weekly bulletins.
5. Use local exhaust ventilation and isolation techniques to control for renovation pollutants. Precautions should be taken to avoid the re-entrainment of these materials into the school's HVAC system. The design of each system must be assessed to determine how it may be impacted by renovation activities. Specific HVAC protection requirements pertain to the return, central filtration and supply components of the ventilation system. This may entail shutting down systems (when possible) during periods of heavy construction and demolition, ensuring systems are isolated from contaminated environments, sealing ventilation

- openings with plastic and utilizing filters with a higher dust spot efficiency where needed (SMACNA, 1995).
6. Obtain Material Safety Data Sheets (MSDS) for all construction materials used during renovations and keep them in an area that is accessible to all individuals during periods of building operations as required by the Massachusetts Right-To-Know Act (MGL, 1983).
 7. Consult MSDS' for any material applied to the effected area during renovation(s) including any sealant, carpet adhesive, tile mastic, flooring and/or roofing materials. Provide proper ventilation and allow sufficient curing time as per the manufacturer's instructions concerning these materials.
 8. Seal utility holes, spaces in floor decking and temporary walls to eliminate pollutant paths of migration. Seal holes created by missing tiles in ceiling temporarily to prevent renovation pollutant migration.
 9. If possible, relocate susceptible persons and those with pre-existing medical conditions (e.g., hypersensitivity, asthma) away from areas of renovations.
 10. Implement prudent housekeeping and work site practices to minimize exposure to renovation pollutants. This may include constructing barriers, sealing off areas, and temporarily relocating furniture and supplies. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended.
 11. Consider changing filters for HVAC equipment more regularly in areas impacted by renovation activities. Examine the feasibility of acquiring more efficient filters for these units.

References

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Picture 1



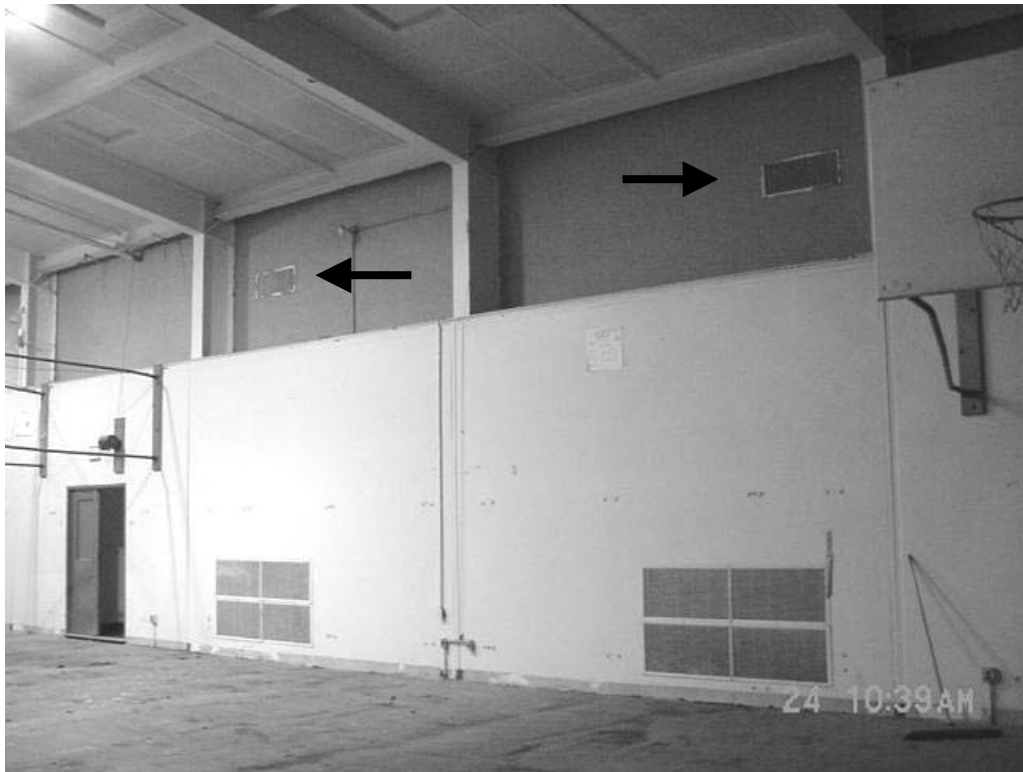
Gymnasium AHU Located in Mechanical Room Loft

Picture 2



Fresh Air Intake for Gymnasium AHU

Picture 3



Supply (indicated by arrows) and Return Vents (along wall near floor) in Gym

Picture 4



Supply Vents for Locker Room(s)

Picture 5



Wall-Mounted Univent in Weight Room off Gym

Picture 6



Outside Air Intake for Weight Room Univent

Picture 7



Ceiling-Mounted Exhaust Vent in Weight Room

Picture 8



Rooftop Exhaust Motors

Picture 9



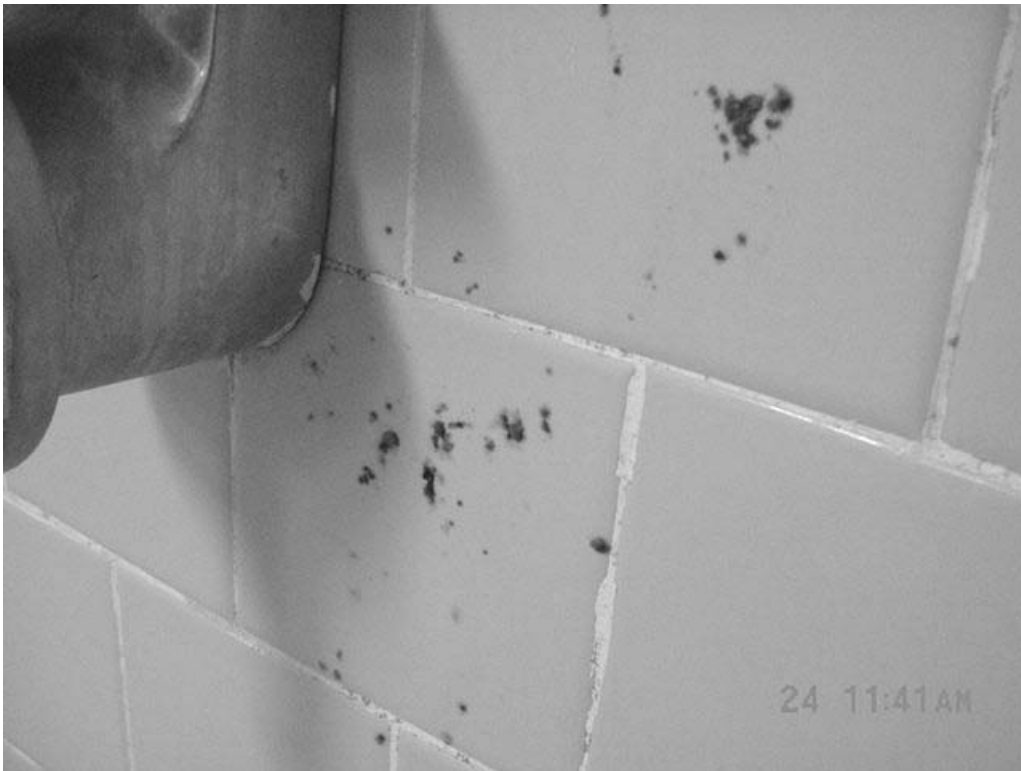
Peeling Paint on Ceiling of Girl's Locker Room

Picture 10



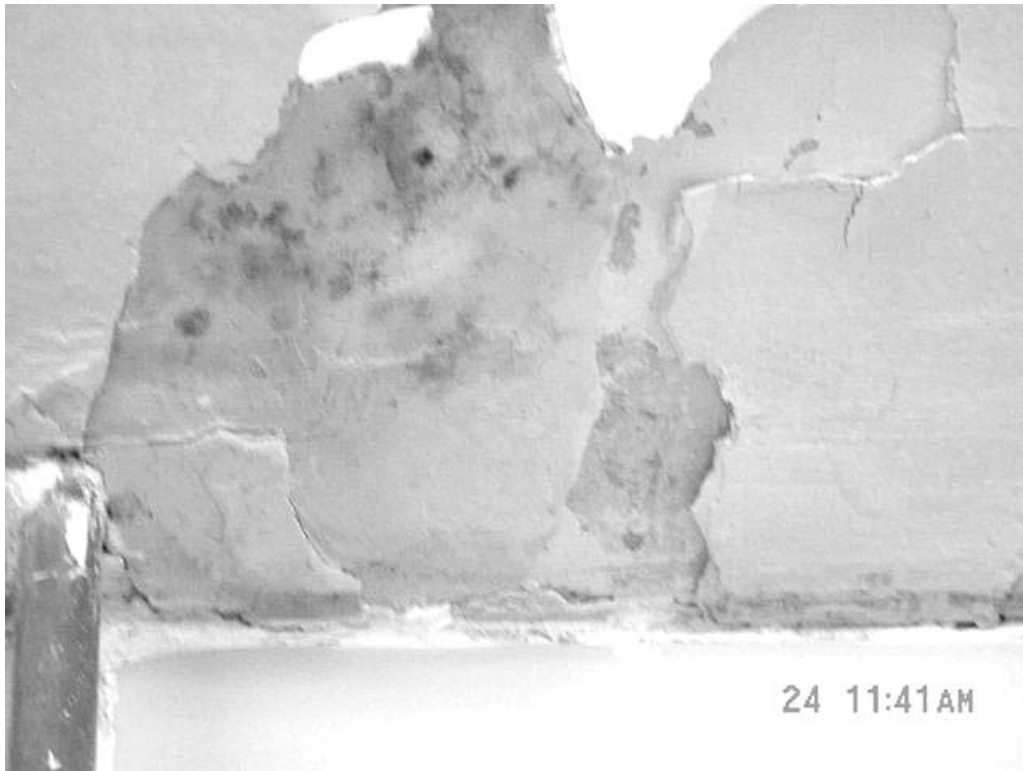
Water Damaged Ceiling Plaster & Efflorescence on Girl's Locker Room

Picture 11



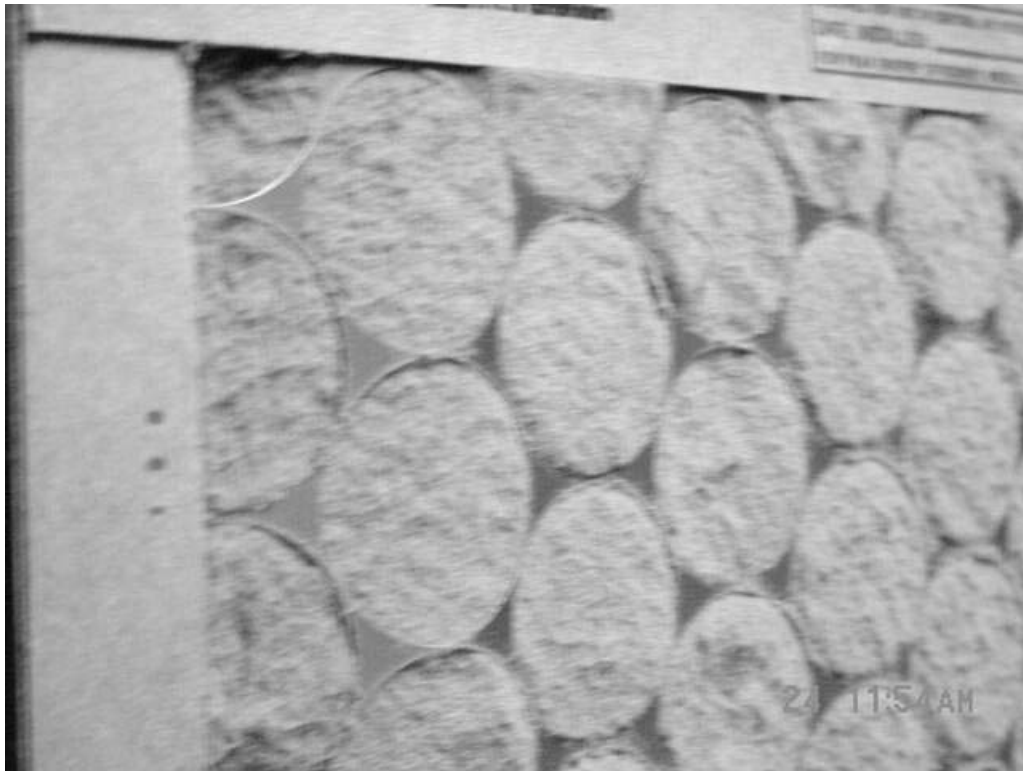
Mold Growth (black spots) on Shower Tiles in Boy's Locker Room

Picture 12



Mold Growth (black spots) on Ceiling in Shower Area of Boy's Locker Room

Picture 13



Gymnasium AHU Air Filter Occluded With Dust & Debris

TABLE 1

Indoor Air Test Results – Leicester Middle School, Leicester, MA – May 25, 2001

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	448	62	39					Weather conditions: cool & cloudy, Easterly wind 10-15 mph, following three days of rain
Gym	470	63	51	0	No	Yes	Yes	HVAC system deactivated due to renovations, exhaust louvers partially shut
Weight Room	468	62	50	0	No	Yes	Yes	2-wall mounted univents-off
Girl's Locker Room	690	63	53	0	No	Yes	Yes	HVAC-off, historic water damage: ceiling plaster & peeling paint
Boy's Locker Room	584	64	49	0	No	Yes	Yes	HVAC-off, Water damaged ceiling plaster, mold growth on ceiling and shower tiles
Gym Instructor's Office	770	64	49	0	No	Yes	Yes	HVAC-off

* ppm = parts per million parts of air
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%